CARIBOO FOREST REGION RESEARCH SECTION

Extension Note

"Making Research Work for You"

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RESEARCH ISSUE GROUPS

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- Hydrology
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Cariboo Forest Region, BC

Suitability of Native Hardwoods for Reforestation in the Cariboo Forest Region

INTRODUCTION

Forest management in the Cariboo Forest Region, and in British Columbia in general, has traditionally focused on conifer management and harvesting. However, growing concerns for biodiversity and habitat, along with increasing interest in the potential of hardwoods to supplement the timber supply, have heightened recognition of the role of hardwoods in forest resource management. The most prevalent hardwood species in the Cariboo, in descending order, are trembling aspen (*Populus tremuloides*), paper birch (*Betula papyrifera*) and black cottonwood (*Populus balsamifera* spp *trichocarpa*), and together they form 2% of the total mature forest volume in the Cariboo Forest Region (BC Ministry of Forests, 1990). Trembling aspen covers 200 180 ha and amounts to a volume of 16 million m^3; paper birch covers 15 150 ha, with a total volume of 1.5 million m^3 (Massie *et al.*, 1994).

Hardwoods have a number of valuable characteristics. They generally grow more quickly than conifers do and reach merchantable size at an earlier age. With their annual leaf fall, aspen and birch can enhance soil properties through nutrient cycling from leaf decomposition. Black cottonwood is important in alluvial floodplain and river-bank stabilization, where it often exhibits its best growth (Haeussler and Coates, 1986). And hardwood stands, overall, contribute significantly to biodiversity attributes and wildlife habitat.

Compared to conifers,

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hardwoods also are usually more resistant to such root disease pathogens as Armillaria root disease (*Armillaria ostoyae).* As Armillaria is commonly found on transition sites between the Sub-Boreal Spruce (SBS) and Interior Cedar Hemlock (ICH) in the Cariboo Forest Region, this means that hardwoods may provide a valuable alternative on infected sites to conifers, either as pure or mixedwood stands (Sutherland and Hunt, 1990). Hardwoods also tend to be less susceptible than conifers to tomentosus root rot (*Ionotus tomentosus*) and laminated root rot (*Phellinus weirii).*

Finally, hardwoods may be more tolerant to the summer frosts that often occur on dry, cold sites and may damage exposed conifer seedlings. This makes them potentially useful on these sites either as a single species or as a protective overstory for conifers.

TRIAL PURPOSE AND OBJECTIVES

The trial described here was established to compare survival and growth of native hardwood and conifer species on a range of sites in the Cariboo Forest Region. Also being examined is the susceptibility of hardwoods to insects, diseases, frost, decay, and damage from large and small mammals, as well as the feasibility of establishing hardwood stands.

Specifically, the objectives of the trial are to:

- Compare the survival and growth of three native hardwoods (trembling aspen, paper birch and black cottonwood) to that of lodgepole pine and Interior spruce or Douglas-fir on five sites in the Cariboo Forest Region.
- Determine the susceptibility of these hardwood species throughout the rotation to insects, disease (particularly Armillaria root rot), large and small mammal damage, frost and decay.
- Determine whether these hardwood species will improve the long-term soil nutrient status of the site.
- Determine the appropriate spacing for growing hardwoods in the ICHwk2 subzone of the Cariboo Forest Region.

TRIAL BACKGROUND

The trial was established in spring 1993 on five sites in the Cariboo Forest Region. The sites, which were selected to cover a range of ecosystems, are summarized in Table 1. The five trial species – aspen, birch, cottonwood, Interior spruce and lodgepole pine – were planted on each site with some exceptions. Douglas-fir was substituted for Interior spruce at Meadow Lake and two hybrid poplars were additionally planted on the 13A Road site.

All sites were planted at 2.5 m inter-tree spacing (1600 sph), except for the Crooked Lake site where additional spacings of 800 and 3200 sph were used.

Figures 1 and 2 show samples of aspen and birch seedlings grown for this trial.

Table 1. Summary of five trial sites and species planted

Location	Forest District	BEC Subzone	Elevation (m)	Comments
Big Lake	Williams Lake	SBSdw1	900	
UBC Alex Fraser Research Forest	Horsefly	SBSdw1	1000	Armillaria root disease site
Crooked Lake	Horsefly	ICHwk2	1000	All species planted at three spacings (800, 1600, 3200 sph)
13A Road	Quesnel	SBSwk1	975	Two hybrid poplars also planted
Meadow Lake	100 Mile House	IDFdk4	1050	Douglas-fir substituted for Interior spruce

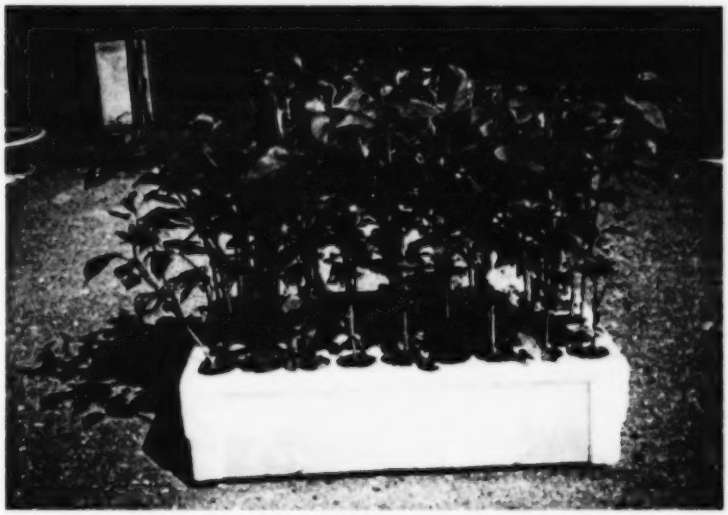

Fig. 1. Aspen seedlings in the PSB 615 container.

Fig. 2. Birch seedling grown in a PSB 415 container.

RESULTS

This Extension Note is based on the five-year results reported in Daintith (1999).[1]

Seedling Survival

One year after planting, 98-100% of the conifers and at least 85% of the hardwoods had survived. Aspen survival was generally lowest on all sites. After five growing seasons, however, survival dropped for all conifer and hardwood species, as shown in Figure 3. For all five sites, survival of the conifers was generally higher than that of the hardwoods, except for the Meadow Lake site where survival of all three hardwood species was higher than the 29% survival rate of Douglas-fir.

Survival of all hardwoods was lowest on the UBC Alex Fraser Research Forest (UBC/AFRF) site. Aspen survival was highest on the Meadow Lake (90%) and Big Lake (89%) sites, which are the two driest locations (IDFdk4 and SBSdw1, respectively). Survival of cottonwood (76%) and birch (88%) was highest on the 13A Road site (SBSwk1). Planting density tested at Crooked Lake had no consistent impact on seedling survival for any species.

Hardwood survival was poor on the UBC/AFRF site due to heavy browsing by ungulates in the two years after planting. However, more than 90% of the surviving seedlings are in good or fair condition and are expected to reach free-growing status. Condition of hardwoods and conifers is comparable on this site. On the other sites, the conifers (except for Douglas-fir at Meadow Lake) are generally in better condition than the hardwoods, with a higher percentage of coniferous seedlings expected to reach free-growing status.

Seedling Growth

Fifth-year height and diameter of the trial species (Figures 4 and 5), as well as their height and diameter growth since planting, are significantly different among sites, as described below.

[1] Daintith, N. 1999. Suitability of native hardwoods for reforestation and their effect on long-term soil nutrient status (EP 1136.01). 5th-Year Rep. Unpub. doc. March 31.

Big Lake (SBSdw1)
After five years, lodgepole pine and aspen, with mean heights of 107 cm and 102 cm, respectively, are nearly twice as tall as the cottonwood (56 cm), the next tallest species. Lodgepole pine has outgrown the tallest hardwood species (aspen) since the third growing season. Birch has grown poorly on this site, adding only 17 cm in height since planting as a result of heavy browsing by cattle.

Lodgepole pine diameter growth since planting (17.2 mm) has far surpassed that of all the other species. Spruce has the second highest diameter growth, at 7.3 mm. Diameter growth of birch has been marginal since planting, but diameter growth of aspen and cottonwood has improved in the last two years over that in the first three growing seasons.

UBC Alex Fraser Research Forest (SBSdw1)
The aspen seedlings were the tallest seedlings planted on this site and they maintained their height advantage for the first three growing seasons. After five years, however, aspen was surpassed by lodgepole pine which, at a height of 145 cm, is significantly taller than all other species. Aspen is significantly taller than only the cottonwood or spruce. Total height growth of lodgepole pine since planting (130 cm) is also significantly greater than that of all other species.

Diameter growth and total diameter of lodgepole pine have also exceeded that of the other species. Total diameter growth of pine since planting (22.2 mm) is almost twice that of the spruce (11.5 mm) which has the next highest diameter growth. Diameter growth of spruce is comparable to that of birch (11.2 mm) and aspen (8.8 mm), and all three species have shown significantly better diameter growth since planting than has cottonwood (5.8 mm).

Crooked Lake (ICHwk2)
Lodgepole pine has surpassed aspen in height growth since the end of the third growing season and, at a mean height of 153 cm, it is significantly taller than all other species, which have comparable height growth and total height. Height growth of the birch and aspen has been comparable over the last two years, growing 18 cm and 24 cm, respectively. The low growth rate of these two species can be attributed to browsing by horses and possibly ungulates.

Lodgepole pine also has the highest mean diameter growth (30.4 mm) and the largest mean diameter. At the end of the first growing season, the mean diameter of all hardwoods was significantly larger than that of the conifers. Since the end of the third growing season, however, this trend has reversed. Although the mean

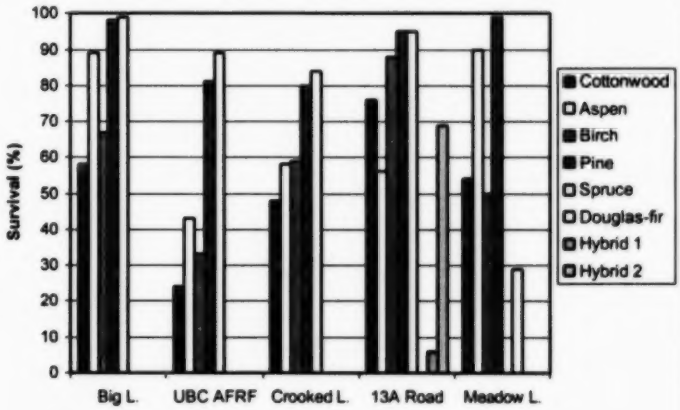

Fig. 3. Five-year survival by site and species.

diameter of spruce (21.9 mm) is notably larger than the mean diameter of the hardwoods, the difference is not statistically significant.

Fifth-year height and diameter, and height and diameter growth since planting, were compared for the three planting densities (inter-tree distances of 1.75 m, 2.5 m and 3.5 m) used at this site. As there was no evidence to suggest differences between spacing treatments for these variables, the data have been combined for reporting purposes.

13A Road (SBSwk1)

After three growing seasons, all hardwoods, with the exception of hybrid poplar H1, were significantly taller than either lodgepole pine or spruce. Hybrid poplar H1 experienced significant first-year mortality due to frost damage (only 6% survived) and is not included in any analysis. Since the third growing season, birch has maintained its height advantage and remains the tallest species, with a mean height of 132 cm. Lodgepole pine has grown approximately 32 cm annually over the last two years, with a mean height of 129 cm – comparable to that of birch. Comparing the height growth curves of these two species, lodgepole pine is expected to have the best height growth in the future. Additionally, native cottonwood appears to be growing better than hybrid poplar H2, even though the hybrid poplar was the taller of the two species at the end of the third growing season. There are very few significant differences in total height between species. Spruce currently has the lowest mean height (94 cm), but it is not significantly shorter than the other species when planting height is considered.

While lodgepole pine is expected to soon outgrow birch in height, it has already surpassed birch in diameter. Mean diameters of pine (32.6 mm), birch (24.6 mm) and spruce (21.2 mm) are comparable and significantly larger than the mean diameters of the other hardwoods. The other hardwoods have shown very little diameter growth since the end of the third growing

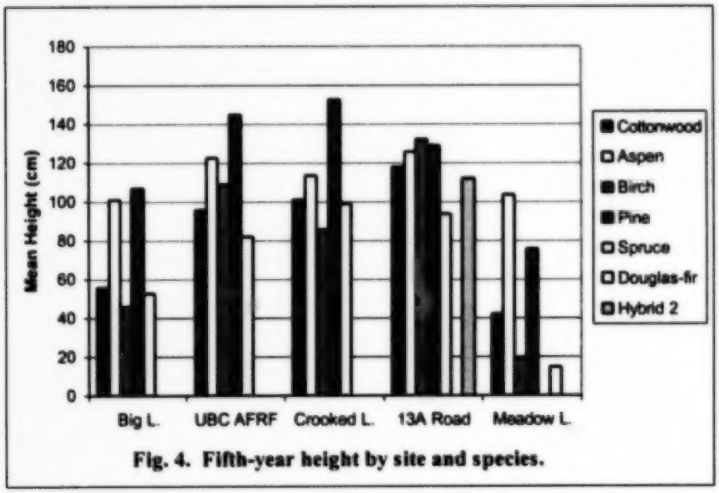

Fig. 4. Fifth-year height by site and species.

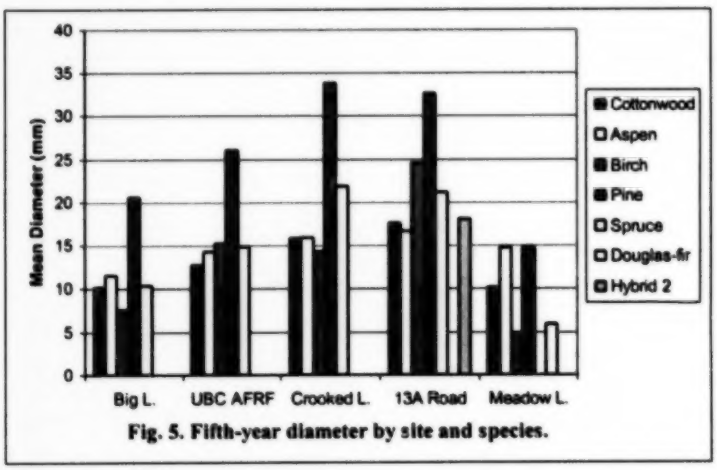

Fig. 5. Fifth-year diameter by site and species.

season (two-year increments ranged from a low of 4.4 mm for hybrid poplar H2 to a high of 6.3 mm for cottonwood).

Meadow Lake (IDFdk4)
Aspen had the highest mean planting height and has maintained this height advantage over five growing seasons. Current mean height of aspen (104 cm) is not significantly different from that of lodgepole pine (76 cm) when planting height is used in the analysis (aspen was the tallest species at planting and pine was the shortest). Since the end of the third growing season, height growth of aspen and lodgepole pine has been comparable. On this dry site, the height growth of all other species has been poor. After five growing seasons, birch is shorter than when it was planted as a result of repeated browsing by cattle, and Douglas-fir height growth has been decreased by annual frost damage.

Only aspen and lodgepole pine have shown any amount of diameter growth since planting. At five years, both species had equal diameters of 14.8 mm. However, diameter growth of pine over the last two years indicates that the mean diameter of ıe will soon exceed that of aspen. Similar to height growth, total diameter growth of the other species has been marginal since planting.

Seedling Damage

Most of the coniferous seedlings, except Douglas-fir planted at Meadow Lake, are generally free of damage. Very little damage was noted on lodgepole pine on any site. Cooley spruce gall adelgid (*Adelges cooleyi*) was noted on 20% and 39% of the spruce at the 13A Road and Crooked Lake sites, respectively, and on a small percentage of spruce at the UBC/AFRF site. At Crooked Lake, frost damage was reported on spruce in the third-year assessment and most of these seedlings now have forked stems. Douglas-fir at Meadow Lake has been subjected to annual frost damage, resulting in a high rate of mortality or poor growth since planting on surviving seedlings.

On all sites, the hardwoods seem to be more susceptible to damage. On the 13A Road site, approximately 20% of the hardwood stems have been bent by snow press. This damage was particularly evident in the first three growing seasons when the stems were small and pliable. The hardwood seedlings at the Meadow Lake, Crooked Lake and 13A Road sites have been browsed by cattle, horses and big game (probably moose), respectively. At Meadow Lake, birch has been most heavily browsed; at Crooked Lake, all hardwoods have been damaged by browsing.

Vegetation Competition

The 13A Road site was assessed early in the spring of 1998. Although vegetation cover (predominantly fireweed) could not be evaluated, fifth-year seedling heights indicate that most seedlings are growing above the surrounding vegetation. On all other sites, vegetation competition was assessed in late summer of 1997 and was not found to be a serious problem. There were a few exceptions to this trend: 47% of the birch at Big Lake and approximately 30% of the Douglas-fir and birch at Meadow Lake were overtopped.

SUMMARY

Five years of monitoring show changes in initial growth trends on most sites. The hardwood stock was larger than the coniferous stock at the time of planting, but this height advantage has been maintained on only two sites. Lodgepole pine has performed very well on all sites, and in the last two years has outgrown most hardwoods, with the exception of aspen on the Meadow Lake site and birch on the 13A Road site. If current growth rates continue, pine is expected to be the best performer of all species on all of the trial sites. However, the growth of planted aspen in this trial may not reflect the growth of aspen that vegetatively regenerates from an established root system. As well, although it is premature to determine the tolerance of the hardwoods to Armillaria root disease on the UBC/AFRF site, some mortality is expected over time, especially for pine and spruce.

RECOMMENDATIONS

The following recommendations concerning the use of hardwoods for reforestation in the Cariboo Forest Region are based on the preliminary data and observations from this trial.

1. Birch grows well on wetter sites (SBSwk1 and ICHwk2), but tends to be heavily browsed by livestock and moose. As a result, it should not be planted in areas used as range for cattle or horses, or in areas with high moose browsing. Birch also appears to be susceptible to early fall frosts and therefore should not be planted on frost-prone sites or in low areas of a block where frost may collect.

2. Generally, most hybrid poplars tested in British Columbia have shown low frost tolerance. However, one of the hybrid poplars tested in this trial has performed well on the 13A Road site, with its survival and growth comparable to that of native cottonwood. Like birch, cottonwood is recommended for wetter sites (ICHwk2 and SBSwk1), while hybrid poplar is recommended for low frost hazard sites in the SBSwk1. Hot planting rooted cuttings of cottonwood and hybrid poplars in the late spring, after any risk of a last hard frost has passed, is also recommended over planting unrooted whips of these species.

3. Aspen has shown the best height growth on the drier sites (SBSdw1 and IDFdk4) that receive low snowfall amounts. Planting aspen on high snowfall sites is not recommended because of the high incidence of bent stems and broken branches caused by snow press.

4. Five years of observations in this trial suggest that hardwoods may be suitable for reforesting compacted areas of a cutblock. On the 13A Road site, for example, growth and vigour of the hardwoods far exceeds that of the conifers on compacted skid trails. Further study is recommended to investigate this potential use of hardwoods.

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